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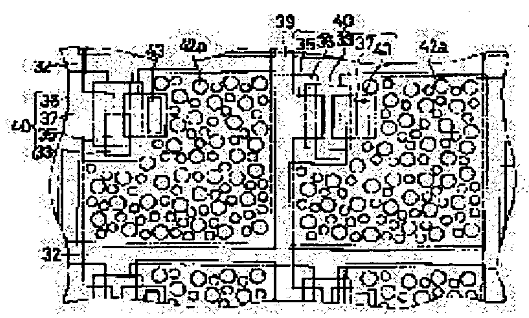
(54) REFLECTING TYPE LIQUID CRYSTAL DISPLAY DEVICE AND MANUFACTURE THEREOF

(57)Abstract:

PROBLEM TO BE SOLVED: To manufacture a reflecting plate with an excellent reflection characteristic with ease and good reproducibility, and to improve a display quality, by configuring an insulating film forming a reflecting electrode of a rugged organic resin, and equalizing the arrayed pattern of the ruggedness in a plurality of reflecting electrode forming areas.

SOLUTION: On a reflecting electrode, projecting part is irregularly formed via projection part 42a formed on an organic insulating film 40. And, this irregularity of the projecting part of the reflecting electrode is the same with any reflecting electrode. That is because shielding areas are formed in a same array pattern in areas corresponding to each reflecting electrode of a photo mask used when the projecting part 42a is formed on the organic insulating film 40. Since the ruggedness is formed only on the reflecting electrode part, insufficient insulation resistance does not occur between a source bus wiring 39 and the reflecting electrode, and improves display quality. Moreover, since the array pattern of the projecting part 42a is the same on each reflecting electrode, and makes it easy to form the projecting part.



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CLAIMS

[Claim(s)]
[Claim 1] It is the reflective mold liquid crystal display with which the array pattern of this irregularity is characterized by the same thing in the formation field of said at least two or more reflectors while consisting of organic resin with which said insulator layer has irregularity in the reflective mold liquid crystal display with which the reflector which reflects the incident light from an another side substrate side through an insulator layer on the substrate of the one side of the substrates of the pair by which opposite arrangement is carried out by intervening a liquid crystal layer is formed.
[Claim 2] The reflective mold liquid crystal display according to claim 1 with which the array pattern of the irregularity formed in said insulator layer is characterized by the same thing in the formation field of said all reflectors.
[Claim 3] In the manufacture approach of a reflective mold liquid crystal display of having the reflector which reflects the incident light from an another side substrate side on the substrate of the one side of the substrates of the pair by which opposite arrangement is carried out by intervening a liquid crystal layer Said process which applies a photopolymer to the liquid crystal layer side on a substrate on the other hand, and the process which heat-treats after exposing and developing said photopolymer through a protection-from-light means by which the pattern of an approximate circle form was arranged irregularly, and forms two or more concave heights, The manufacture approach of a reflective mold liquid crystal display that the gross area of the pattern of the approximate circle form arranged by said protection-from-light means is characterized by being 40% or more of the gross area of said reflector including the process which forms said reflector which consists of a metal thin film on said two or more concave heights.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]

[Field of the Invention] This invention relates to the reflective mold liquid crystal display which displays by reflecting the incident light from the outside, and its manufacture approach.
[0002]
[Description of the Prior Art] In recent years, application of the liquid crystal display to a word processor, a laptop type personal computer, pocket television, etc. is progressing quickly. Since the back light is unnecessary, power consumption is low and is a thin form, and since lightweight-izing is possible, especially the reflective mold liquid crystal display that displays from the outside also in a liquid crystal display by reflecting the light which carried out incidence attracts attention.
[0003] from the former, also although kicked, by these methods, one half of the optical reinforcement of the natural light will be inevitably used for a display with a polarizing plate, and the problem for which TN (Twisted Nematic) method and the STN (Soe Patsy Stead pneumatic) method are used that a display becomes dark is shown in a reflective mold liquid crystal display.
[0004] Not using the polarizing plate, the display mode which is going to use all the beams of light of the natural light effectively is proposed to such a problem. As an example in such the mode, a phase transition mold guest host method is held (D. L.White and G.N.Taylor:J.Appl.Phys.45 4718 1974). In this mode, the cholesteric nematic phase transition phenomenon by electric field is used. The reflective mold multicolor display which combined the micro color filter with this method further is also proposed (Tohru Koizumi and Tatsuo Uchida Proceedings of the SID.Vol.29/2.157.1988).
[0005] In order to obtain a still brighter display in the mode which does not need such a polarizing plate, it is necessary to make the luminous intensity scattered about in the direction perpendicular to the display screen increase to the incident light from all include angles. For that purpose, it is necessary to create the reflecting plate which has the optimal reflection property. Surface irregularity is controlled and the reflecting plate in which the silver thin film was formed on the irregularity is indicated by by changing into above-mentioned reference the time amount which carries out surface roughening of the front face of the substrate which consists of glass etc. by the abrasive material, and is etched by the hydrofluoric acid.
[0006] However, since irregularity is formed by giving a blemish to a glass substrate by the abrasive material, the irregularity of a uniform configuration is not formed in a reflecting plate given in the above-mentioned reference. Moreover, since there is a problem that the repeatability of a concavo-convex configuration is bad, if such a glass substrate is used, the reflective mold liquid crystal display which has a good reflection property with sufficient repeatability cannot be offered.
[0007] Drawing 25 is the top view of the substrate 2 which has the thin film transistor (it is hereafter described as "TFT".) 1 which is the switching element used for an active matrix, and drawing 26 is the sectional view seen from cutting plane line X26-X26 shown in drawing 25 . On the substrate 2 of insulation, such as glass, two or more gate bus wiring 3 which consists of chromium, a tantalum, etc. is formed in parallel mutually, and the gate electrode 4 is branched and formed from the gate bus wiring 3. The gate bus wiring 3 is functioning as the scanning line.
[0008] The gate dielectric film 5 which covers the gate electrode 4 and consists of silicon nitride (SiNx), silicon oxide (SiOx), etc. the whole surface on a substrate 2 is formed. On the upper gate dielectric film 5 of the gate electrode 4, the semi-conductor layer 6 which consists of amorphous silicon (it is hereafter described as "a-Si".), polycrystalline silicon, CdSe, etc. is formed. In one edge of the semi-conductor layer 6, superposition formation of the source electrode 7 which consists of titanium, molybdenum, aluminum, etc. is carried out. Moreover, superposition formation of the drain electrode 8 which consists of titanium, molybdenum, aluminum, etc. is carried out like the source electrode 7 at the other-end section of the semi-conductor layer 6. In the edge of the opposite side, superposition formation of the picture element electrode 9 which consists of ITO (Indium Tin Oxide) is carried out in the semi-conductor layer 6 of the drain electrode 8.
[0009] As shown in drawing 25 , the source bus wiring 10 which crosses on both sides of the gate bus wiring 3 and the above-mentioned gate dielectric film 5 is connected to the source electrode 7. The

source bus wiring 10 is functioning as a signal line. The source bus wiring 10 is also formed with the same metal as the source electrode 7. The gate electrode 4, gate dielectric film 5, the semi-conductor layer 6, the source electrode 7, and the drain electrode 8 constitute TFT1, and this TFT1 has the function of a switching element.
[0010] If it is going to apply the substrate 2 which has TFT1 shown in drawing 25 and drawing 26 to a reflective mold liquid crystal display, it is necessary it not only to form the picture element electrode 9 with the metal which has light reflex nature, such as aluminum and silver, but to form irregularity gate dielectric film 5 or on it. It is difficult to form in homogeneity the irregularity which the taper generally attached to the insulator layer which consists of an inorganic substance.
[0011] Drawing 27 is the top view of the substrate 12 which has TFT11 used for an active matrix, and drawing 28 is the sectional view seen from cutting plane line X28-X28 shown in drawing 27 . On the substrate 12 of insulation, such as glass, two or more gate bus wiring 13 which consists of chromium, a tantalum, etc. is formed in parallel mutually, and the gate electrode 14 is branched and formed from the gate bus wiring 13. The gate bus wiring 13 is functioning as the scanning line.
[0012] The gate dielectric film 15 which covers the gate electrode 14 and consists of silicon nitride, silicon oxide, etc. the whole surface on a substrate 12 is formed. On the upper gate dielectric film 15 of the gate electrode 14, the semi-conductor layer 16 which consists of a-Si etc. is formed. The contact layer 17 which consists of a-Si etc. is formed in the both ends of the semi-conductor layer 16. On one contact electrode 17, superposition formation of the source electrode 18 is carried out, and superposition formation of the drain electrode 19 is carried out on the contact layer 17 of another side. The source bus wiring 23 which functions as a signal line which crosses on both sides of the gate bus wiring 13 and the above-mentioned gate dielectric film 15 is connected to the source electrode 18. The gate electrode 14, gate dielectric film 15, the semi-conductor layer 16, the contact layer 17, the source electrode 18, and the drain electrode 19 constitute TFT11.
[0013] Furthermore, on it, it has two or more heights 20a, and the organic compound insulator 20 which has a contact hole 21 on the drain electrode 19 is formed. A reflector 22 is formed on an organic compound insulator 20, and the reflector 22 is connected with the drain electrode 19 through the contact hole 21.
[0014] As mentioned above, when forming an organic compound insulator 20 on the substrate 12 in which TFT11 was formed, heights 20a can be easily formed in the front face of an organic compound insulator 20 using the etching method, and the reflector 22 which has irregularity easily can be formed by forming a reflector 22 on the organic compound insulator 20 which has heights 20a.
[0015]
[Problem(s) to be Solved by the Invention] As shown in drawing 25 and drawing 26 , in case a reflector 9 and the source bus wiring 10 are formed on gate dielectric film 5, gap 9a is formed so that a reflector 9 and the source bus wiring 10 may not flow. However, if the source bus wiring 23 is formed on gate dielectric film 15 and a reflector 22 is formed on an organic compound insulator 20, respectively as shown in drawing 27 and drawing 28 , the above gap 9a is unnecessary.
[0016] In order to improve the brightness of a display, a reflector 22 is so desirable that the surface area is large. Therefore, in drawing 27 and drawing 28 , reflector 22 edge is formed on the source bus wiring 23 through the organic compound insulator 20.
[0017] The insulation by the organic compound insulator 20 is not performed, but an organic compound insulator 20 has the problem that the poor insulation of the reflector 22 and the source bus wiring 23 which are formed on an organic compound insulator 20 arises, when poor etching to which the pars-basilaris-ossis-occipitalis 20b part between adjacent heights 20a contacts on the source bus wiring 23 arises, since it has heights 20a.
[0018] Moreover, in order to form the organic compound insulator 20 which has heights 20a the whole surface on a substrate 12, in case patterning of the reflector 22 is carried out, there is a problem that irregularity arises in the periphery section of a reflector 22, and poor patterning of a reflector 22 arises

by heights 20a.
[0019] Furthermore, when a reflector 22 is formed through an organic compound insulator 20 on the semi-conductor layer 16 of the connection part on the gate [which was formed on the substrate 12] electrode 14 which it takes about and is an electrode, The signal concerning a reflector 22 starts the semi-conductor layer 16, the function as the gate electrode 14 with the reflector 22 same in false is achieved, a channel is formed in the interface of a reflector 22 and the semi-conductor layer 16, and the property of TFT11 is reduced. Moreover, big parasitic capacitance will occur between the gate electrode 14 and a reflector 22. These phenomena become the cause of reducing display grace.
[0020] The purpose of this invention is offering the reflective mold liquid crystal display whose display grace's can solve an above-mentioned problem, and can create the reflecting plate which has a good reflection property with easily and sufficient repeatability, and improves, and its manufacture approach.
[0021]
[Means for Solving the Problem] In the reflective mold liquid crystal display with which the reflector which reflects the incident light from an another side substrate side through an insulator layer on the substrate of the one side of the substrates of the pair by which opposite arrangement is carried out by this invention intervening a liquid crystal layer is formed Said insulator layer is a reflective mold liquid crystal display with which the array pattern of this irregularity is characterized by the same thing in the formation field of said at least two or more reflectors while consisting of organic resin which has irregularity.
[0022] Moreover, it is characterized by the array pattern of this invention of the irregularity formed in said insulator layer being the same in the formation field of said all reflectors.
[0023] In the manufacture approach of a reflective mold liquid crystal display of having the reflector which reflects the incident light from an another side substrate side on the substrate of the one side of the substrates of the pair by which opposite arrangement is carried out by this invention intervening a liquid crystal layer Said process which applies a photopolymer to the liquid crystal layer side on a substrate on the other hand, and the process which heat-treats after exposing and developing said photopolymer through a protection-from-light means by which the pattern of an approximate circle form was arranged irregularly, and forms two or more concave heights, The gross area of the pattern of the approximate circle form arranged by said protection-from-light means including the process which forms said reflector which consists of a metal thin film on said two or more concave heights is the manufacture approach of the reflective mold liquid crystal display characterized by being 40% or more of the gross area of said reflector.
[0024] Hereafter, the operation is briefly explained about the reflective mold liquid crystal display and its manufacture approach of this invention.
[0025] If this invention is followed, it is not necessary to form a reflective mold liquid crystal display by array pattern which has the reflector with the same array pattern of said concave heights, therefore is different for every reflector, and it will become possible [forming said concave heights in all the fields in which a reflector is formed easily]. That is, since a protection-from-light field is formed by the respectively same array pattern on the photo mask of the field corresponding to a reflector, creation of a photo mask is [that what is necessary is just to form the array pattern corresponding to one reflector] easily possible.
[0026] Moreover, if this invention is followed, since the gross area of the protection-from-light field in which the pattern of said approximate circle form was formed is made into 40% or more of the gross area of a reflector, in the manufacture approach of a reflective mold liquid crystal display, said protection-from-light means will become possible [obtaining a high reflection factor]. That is, since a specular reflection component does not increase but dispersion increases by making the gross area of the protection-from-light field of a protection-from-light means into 40% or more of the gross area of a reflector, it is possible to obtain a high reflection factor in the viewing-angle range of an observer.
[0027]

[Embodiment of the Invention] Drawing 1 is the sectional view of the reflective mold liquid crystal display 30 which is 1 operation gestalt of this invention, and drawing 2 is the top view of the substrate 31 shown in drawing 1 R> 1. On the insulating substrate 31 which consists of glass etc., two or more gate bus wiring 32 which consists of chromium, a tantalum, etc. was formed in parallel mutually, and the gate electrode 33 has branched from the gate bus wiring 32. The gate bus wiring 32 is functioning as the scanning line.

[0028] The gate dielectric film 34 which covers the gate electrode 33 and consists of silicon nitride (SiNx), silicon oxide (SiOx), etc. the whole surface on a substrate 31 is formed. On the upper gate dielectric film 34 of the gate electrode 33, the semi-conductor layer 35 which consists of amorphous silicon (it is hereafter described as "a-Si".), polycrystalline silicon, CdSe, etc. is formed. The contact electrode 41 which consists of a-Si etc. is formed in the both ends of the semi-conductor layer 35. On one contact electrode 41, superposition formation of the source electrode 36 which consists of titanium, molybdenum, aluminum, etc. is carried out, and superposition formation of the drain electrode 37 which consists of titanium, molybdenum, aluminum, etc. is carried out like the source electrode 36 at the contact electrode 41 top of another side.

[0029] As shown in drawing 2 , the source bus wiring 39 which intersects the gate bus wiring 32 on both sides of the above-mentioned gate dielectric film 34 is connected to the source electrode 36. The source bus wiring 39 is functioning as a signal line. The source bus wiring 39 is also formed with the same metal as the source electrode 36. The gate electrode 33, gate dielectric film 34, the semi-conductor layer 35, the source electrode 36, and the drain electrode 37 constitute a thin film transistor (it is hereafter described as "TFT".) 40, and this TFT40 has the function of a switching element.

[0030] The gate bus wiring 32, the source bus wiring 39, and TFT40 are covered, and the organic compound insulator 42 is formed all over the substrate 31 top. Heights 42a of height H in which the point was formed in the shape of the spherical surface is formed in the field in which the reflector 43 of an organic compound insulator 42 is formed by the shape of a taper, and the contact hole 43 is formed in the part of the drain electrode 37. In order to make small the formation approach of an organic compound insulator 42, and variation of the liquid crystal thickness at the time of creating the problem on the process which forms a contact hole 43 in this, and a liquid crystal display 30, height H of heights 42a has desirable 10 micrometers or less.

[0031] Generally, the thickness of a liquid crystal layer is 10 micrometers or less. The reflector 38 which consists of aluminum, silver, etc. is formed on the heights 42a formation field of an organic compound insulator 42, and a reflector 38 is connected with the drain electrode 37 in a contact hole 43. Furthermore on it, the orientation film 44 is formed.

[0032] A color filter 46 is formed on a substrate 45. In the field to which a color filter 46 counters the reflector 38 of a substrate 31, filter 46b in the field which is formed and does not counter a reflector 38 with black Magenta or green filter 46a is formed. The whole surface on a color filter 46, the transparent electrode 47 which consists of ITO (Indium TinOxide) etc. is formed, and the orientation film 48 is further formed on it.

[0033] It counters so that a reflector 38 and filter 46a may be in agreement, and liquid crystal 49 is poured in between lamination ** and a substrate, and the reflective mold liquid crystal display 30 completes said both substrates 31 and 45.

[0034] Drawing 3 is process drawing explaining the formation approach which forms the reflector 38 which has the irregularity shown in drawing 1 and drawing 2 on a substrate 31, drawing 4 is a sectional view explaining the formation approach shown in drawing 3 , and drawing 5 is the top view of the mask 51 used at the process s7 of drawing 3 . Drawing 4 (1) shows the process s4 of drawing 3 , drawing 4 (2) shows the process s7 of drawing 3 , drawing 4 (3) shows the process s8 of drawing 3 , and drawing 4 (4) shows the process s9 of drawing 3 .

[0035] At a process s1, a tantalum metal layer with a thickness of 3000A is formed by the sputtering method on the insulating substrate 31 which consists of glass etc., a HOTORISO graphic method and

etching perform patterning for this metal layer, and the gate bus wiring 32 and the gate electrode 33 are formed. At a process s2, the gate dielectric film 34 which consists of silicon nitride with a thickness of 4000A by the plasma-CVD method is formed.

[0036] In a process s3, an a-Si layer with a thickness of 1000A it is thin in the semi-conductor layer 35, and an n+ mold a-Si layer with a thickness of 400A it is thin in the contact layer 41 are continuously formed in this order. Patterning of the formed n+ mold a-Si layer and an a-Si layer is performed, and the semi-conductor layer 35 and the contact layer 41 are formed. At a process s4, a molybdenum metal with a thickness of 2000A is formed by the spatter all over a substrate 31, patterning of this molybdenum metal layer is performed, the source electrode 36, the drain electrode 37, and the source bus wiring 39 are formed, and TFT40 is completed. Drawing 4 (1) is the sectional view of a substrate 31 in which TFT40 after the processing termination to a process s4 was formed.

[0037] At a process s5, polyimide resin is formed in the thickness of 2 micrometers the whole surface on the substrate 31 in which TFT40 was formed, and an organic compound insulator 42 is formed. At a process s6, a contact hole 43 is formed in an organic compound insulator 42 using a HOTORISO graphic method and the dry etching method. At a process s7, a photoresist 50 is applied on an organic compound insulator 42, and patterning of the heights 50a is carried out to a reflector 38 formation field using the mask 51 shown in drawing 5 R> 5. Furthermore, in order to take the angle of heights 50a, it heat-treats in 120 degrees C - 250 degrees C. With the gestalt of this operation, 200 degrees C and heat treatment for 30 minutes were performed. The sectional view of the substrate 31 after the processing termination to a process s7 is shown in drawing 4 (2). Circular protection-from-light field 51a shown with a slash as shown at drawing 5 is irregularly formed in the reflector 38 formation field at the mask 51.

[0038] At a process s8, as shown in drawing 4 (3), a photoresist 50 is covered, an organic compound insulator 42 is etched, and heights 42a whose height H is 0.5 micrometers is formed. Since it heat-treats to a photoresist 52 and the angle of heights 50a is taken at this time, it is formed in the form where the rough edge of the character of heights 42a was rounded off. Moreover, the organic compound insulator 42 on a contact hole 43 and TFT40 is protected by the photoresist 50, and etching is not performed.

[0039] At a process s9, an aluminum layer is formed all over an organic-compound-insulator 42 top, and as shown in drawing 4 (4), a reflector 38 is formed on heights 42a. Let the substrate 31 of this condition be the substrate 52 which has a reflector 38. The reflector 38 is connected with the drain electrode 37 of TFT40 through the contact hole 43 formed in the organic compound insulator 42.

[0040] It is checked that the configuration of heights 42a on an organic compound insulator 42 is controllable by the configuration of a mask 51, the thickness of a photoresist 50, and the time amount of dry etching.

[0041] The substrate 52 which has a reflector 38 was obtained according to the above process. Moreover, in an above-mentioned production process, the substrate 31 which lengthened dry etching time amount of an organic compound insulator 42, and set height H of heights 42a to 1 micrometer can be obtained, and let the substrate 31 which has the reflector 38 whose height H is 1 micrometer be a substrate 59.

[0042] The electrode 47 formed in the substrate 45 of another side shown in drawing 1 consists of ITO, and thickness is 1000A. The orientation film 44 and 48 is formed by calcinating after applying polyimide etc. Between a substrate 31 and 45, by screen-stenciling the adhesive sealing compound which mixed the 7-micrometer spacer and which is not illustrated, the space which encloses liquid crystal 49 is formed and liquid crystal 49 is poured in by carrying out the vacuum deairing of said space. What mixed the optically active substance (the Merck [Co.] make, a trade name: S811) in the guest host liquid crystal (the Merck [Co.] make, a trade name: ZLI2327) which mixed the pigmentum nigrum, for example 4.5% as liquid crystal 49 is used.

[0043] Drawing 6 is the sectional view showing the measuring method of the reflection property of

substrates 52 and 59 which has a reflector 38. A glass substrate 54 is stuck through ultraviolet curing adhesion resin 53 on the substrate 52 which has a reflector 38, and 59, and the equipment 55 for measurement is formed. In the reflective mold liquid crystal display 30, since all of the refractive index of a substrate 45 and liquid crystal 49 are about 1.5, the refractive index of ultraviolet curing adhesion resin 53 and a substrate 54 uses about 1.5 thing. The phot multimeter 56 which measures luminous intensity in the upper part of a substrate 54 is arranged. The phot multimeter 56 is being fixed in the direction of a normal of a substrate 31 so that the scattered light 58 reflected in the direction of a normal of a substrate 31 among the incident light 57 which carries out incidence to a reflector 38 by the incident angle theta to a substrate 31 may be detected.

[0044] The reflection property of a reflector 38 is obtained by changing the incident angle theta of the incident light 57 by which incidence is carried out to the equipment 55 for measurement, and measuring the scattered light 58 by the reflector 38. It is checked that the result as the reflector 38 in the reflective mold liquid crystal display 30 and the reflection property in the boundary of 49 layers of liquid crystal etc. with this same measurement result is obtained.

[0045] Drawing 7 is a graph which shows the reflection property of substrates 52 and 59 which has the reflector 38 of the gestalt of this operation. The reflection property of a substrate 52 is shown by the curve 60, and the reflection property of a substrate 59 is shown by the curve 61. In drawing 7 , the reflectivity of the light which carries out incidence with the incident angle theta is expressed in the direction of the angle theta over a theta= 0-degree line as a distance from a zero 0. Moreover, the curve 62 shown in drawing 7 with a broken line shows the reflection property measured about the standard white plate (magnesium oxide). It has the directivity that the curve 60 which shows the reflection property of a substrate 52 has the large reflection factor of the direction of a normal of a substrate, and the reflection factor of the direction of a normal is small [the curve] when an incident angle is large when an incident angle is small. It turns out to it that the curve 61 which shows the reflection property of a substrate 59 has the curve 62 which shows the reflection property of a standard reflecting plate, and the curve 61 which shows the same reflection property.

[0046] Thus, reflection properties 60 and 61 are controllable by controlling dry etching time amount. Moreover, the magnitude of a specular reflection component is controllable by changing the rate that protection-from-light field 51a of a mask 51 occupies.

[0047] The phot multimeter 56 has been arranged on the reflective mold liquid crystal display 30, and the reflection factor was measured. A reflection factor is obtained by asking for the ratio of the reinforcement of the diffused light 58 to the direction of a normal of the reflective mold liquid crystal display 30 to the reinforcement of the diffused light 58 to the direction of a normal in a standard white plate in case the incident angle theta of incident light 57 is 30 degrees. When an electrical potential difference was impressed, the reflection factor of the reflective mold liquid crystal display 30 to the incident light of theta= 30 degrees of incident angles was quite as bright as about 20%, and the contrast ratio was 5.

[0048] Drawing 8 is the graph which showed the color of the reflected light to the white light source light of the reflective mold liquid crystal display 30 which is 1 operation gestalt of this invention in the CIE chromaticity diagram. A point W1 shows white light source light, a point W2 shows the white displayed by the reflective mold liquid crystal display 30, Point G shows the green displayed by the reflective mold liquid crystal display 30, and Point M shows the Magenta displayed by the reflective mold liquid crystal display 30. It turns out that the point W2 which shows the white of the reflective mold liquid crystal display 30 is close to the point W1 which shows white light source light.

[0049] In the reflective mold liquid crystal display 30 of the gestalt of this operation, since the field in which the reflector 38 was formed is located in a liquid crystal 49 side, parallax is lost and the good display screen is obtained. Moreover, since the reflector 38 which has irregularity serves as a configuration arranged in the location which adjoins mostly 49 layers of 49 layer sides of liquid crystal, i.e., liquid crystal, with the gestalt of this operation, height H of heights 42a is smaller than liquid crystal

.thickness, and, as for whenever [tilt-angle / of heights], it is desirable [H] to make it quiet to extent which does not disturb the orientation of liquid crystal.

[0050] Furthermore, with the gestalt of this operation, although patterning of an organic compound insulator 42 was performed by the dry etching method, when an organic compound insulator 42 is polyimide resin, you may carry out by the wet etching method by the alkali solution. Moreover, although polyimide resin was used as an organic compound insulator 42, other organic materials, such as acrylic resin, may be used. Furthermore, with the gestalt of this operation, as substrates 31 and 45, although the transparent ingredient which consists of glass etc. was used, effectiveness with the same said of an opaque ingredient like a silicon substrate is demonstrated, and there is an advantage which can accumulate a circuit on a substrate in this case.

[0051] In addition, in the gestalt of said operation, although phase transition mold guest host mode was taken up as a display mode, effectiveness with the same said of the birefringence display mode which is not limited to this, for example, is used with other light absorption modes like a two-layer type guest host, a light-scattering mold display mode like a polymer dispersed liquid crystal display, and a ferroelectric liquid crystal display is acquired. Moreover, with the gestalt of this operation, also although it explains and excels about the case where TFT40 is used as a switching element, it is applicable also to the active-matrix substrate using an MIM (Metal-Insulator-Metal) component, diode, a varistor, etc.

[0052] Drawing 9 is the top view having shown two or more reflectors 38 of the substrate 31 in which the gestalt of operation of this invention is shown. On the reflector 38, heights 38a is irregularly formed through heights 42a formed in an organic compound insulator 40. However, the irregularity of heights 38a of a reflector 38 is very the same in which reflector 38. This is because protection-from-light field 51a is formed in the field corresponding to each reflector 38 of the photo mask 51 used in case organic-compound-insulator 42 convex section 42a is formed by the same array pattern.

[0053] Although protection-from-light field 51a of an array pattern which is different, respectively to the field corresponding to each reflector 38 of the photo mask 51 for forming heights 42a can also be designed, if such an approach is taken, the amount of data needed for formation of an array pattern will increase, and creation of a photo mask 51 will become difficult. However, since protection-from-light field 51a is formed by the respectively same array pattern on the photo mask 51 of the field corresponding to each reflector 38 according to the gestalt of this operation, creation of a photo mask 51 becomes easy that what is necessary is just to form the array pattern corresponding to one reflector 38.

[0054] Moreover, heights 42a shown in drawing 9 is formed using the photo mask with which two kinds of circular protection-from-light fields are arranged irregularly. The magnitude of heights 38a set the diameter at the maximum equator of for example, a cross-section configuration to 5 micrometers and 10 micrometers, height was set to 0.6 micrometers, they formed in random only in the field corresponding to one reflector 38, and the remaining picture elements have repeated the array pattern. For example, the magnitude of a picture element created a monochrome reflective mold liquid crystal display which are 300micrometerx300micrometer, the number of picture elements 320x240, and the diagonal size of 5 inches.

[0055] In addition, the configuration of the reflective mold liquid crystal display 30, the creation approach of heights 42a, a display mode, etc. are as having mentioned above. As for the color by interference with the next picture element, the display at the time of making the light switch on completely was not in sight, but good white was obtained.

[0056] What is necessary is just to form a photo mask 51 combining two or more kinds of array patterns, when the number of reflectors 38 increases, the pitch of a reflector 39 becomes small and the interference color with the picture element which especially the next reflector 38 forms poses a problem.

[0057] As mentioned above, according to the gestalt of this operation, in order to form irregularity only in reflector 38 part, the poor insulation of the source bus wiring 39 and a reflector 38 does not arise, and the organic-compound-insulator 42 top of the 38 round edge of reflectors does not have irregularity,

since it is flat, it is not generated but the display grace of poor patterning of the reflective mold liquid crystal display 30 improves. moreover, heights 42a formed in reflector 38 part is arranged irregularly -- having -- the shape of moreover, a taper -- and a point is formed in the shape of the spherical surface, and since it consists of two or more kinds of configurations where one kind differs from magnitude, its reinforcement of the diffused light to the direction of a normal of the reflective mold liquid crystal display 30 improves.

[0058] Moreover, according to the gestalt of this operation, in each reflector 38, the same or since it is the combination of two or more kinds of array patterns, the array pattern of said heights 42a can form heights easily.

[0059] Drawing 10 is the sectional view of the reflective mold liquid crystal display 130 which is the gestalt of operation of this invention, and drawing 11 is the top view of the substrate 131 shown in drawing 10 R> 0. On the insulating substrate 131 which consists of glass etc., two or more gate bus wiring 132 which consists of chromium, a tantalum, etc. was formed in parallel mutually, and the gate electrode 133 has branched from the gate bus wiring 132. It is functioning on the gate bus wiring 130 as the scanning line.

[0060] The gate dielectric film 134 which covers the gate electrode 133 and consists of silicon nitride (SiNx), silicon oxide (SiOx), etc. the whole surface on a substrate 131 is formed. On the upper gate dielectric film 134 of the gate electrode 133, the semi-conductor layer 135 which consists of amorphous silicon (it is hereafter described as "a-Si".), polycrystalline silicon, CdSe, etc. is formed. The contact electrode 141 which consists of a-Si etc. is formed in the both ends of the semi-conductor layer 135. On one contact electrode 141, superposition formation of the source electrode 136 which consists of titanium, molybdenum, aluminum, etc. is carried out, and superposition formation of the source electrode 136 and the drain electrode 137 which consists of titanium, molybdenum, aluminum, etc. similarly is carried out at the contact electrode 141 top of another side.

[0061] As shown in drawing 11 , the source bus wiring 139 which crosses on both sides of the gate bus wiring 132 and the above-mentioned gate dielectric film 134 is connected to the source electrode 136. The source bus wiring 139 is functioning as a signal line. The source bus wiring 139 is also formed with the same metal as the source electrode 136. The gate electrode 133, gate dielectric film 134, the semi-conductor layer 135, the source electrode 136, and the drain electrode 137 constitute a thin film transistor (it is hereafter described as "TFT".) 140, and this TFT140 has the function of a switching element.

[0062] Two or more heights 142a is irregularly formed in the field in which a reflector 138 is formed. The gate bus wiring 132, the source bus wiring 139, TFT140, and heights 142a are covered, and the organic compound insulator 142 is formed all over the substrate 131 top. In an organic compound insulator 142, heights 142b according to heights 142a arises. The contact hole 143 is formed in drain electrode 137 part. In order to make small variation in the liquid crystal thickness at the time of creating a liquid crystal display 130, 10 micrometers or less smaller than the thickness of a liquid crystal layer of the height H1 of heights 142b are desirable. Generally, the thickness of a liquid crystal layer is because it is 10 micrometers or less. Moreover, the pitch of heights 142a has desirable 100 micrometers or less. The reflector 138 which consists of aluminum, silver, etc. is formed on the organic compound insulator 142 on the field in which heights 142a is formed, and a reflector 138 is connected with the drain electrode 137 in a contact hole 143. Furthermore, the orientation film 144 is formed on it.

[0063] As shown in drawing 11 , the reflector 138 is formed so that some gate bus wiring 132 and some source bus wiring 139 may be overlapped through an organic compound insulator 142. For this reason, area of a reflector 138 can be enlarged, the numerical aperture of the display screen becomes large and the bright display of it is attained. What is necessary is just to consider as the configuration which does not form heights 142a at the periphery section of a reflector 138, in order to lose poor patterning of a reflector 138. Moreover, what is necessary is just to consider as the configuration which does not form heights 142a at the part to superimpose, when poor insulation with a reflector 138, the gate bus wiring

132, and the source bus wiring 139 arises.
[0064] A color filter 146 is formed on a substrate 145. In the field to which a color filter 146 counters the reflector 138 of a substrate 131, filter 146b in the field which is formed and does not counter a reflector 138 with black Magenta or green filter 146a is formed. The whole surface on a color filter 146, the orientation film 148 is formed on it at the transparent electrode 147 and pan which consist of ITO etc.
[0065] Spacing is opened, it counters, liquid crystal 149 is poured in between lamination ** and a substrate, and the reflective mold liquid crystal display 130 completes both the substrates 131 and 145 so that a reflector 138 and filter 146a may be in agreement.
[0066] Drawing 12 is process drawing explaining the formation approach which forms the reflector 138 which has the heights shown in drawing 11 and drawing 12 on a substrate 131, drawing 13 is a sectional view explaining the formation approach shown in drawing 12 , and drawing 14 is the top view of the mask 151 used at the process a5 of drawing 12 R> 2. Drawing 13 (2) shows the process a5 of drawing 12 , drawing 13 (3) shows the process a6 of drawing 12 , drawing 13 (1) shows the process a4 of drawing 12 , and drawing 13 (5) shows [drawing 13 (4) shows the process a8 of drawing 12 , and] the process a9 of drawing 12 .
[0067] At a process a1, a tantalum metal layer with a thickness of 3000A is formed by the sputtering method on the insulating substrate 131 which consists of glass etc., a HOTORISO graphic method and etching perform patterning for this metal layer, and the gate bus wiring 132 and the gate electrode 133 are formed. At a process a2, the gate dielectric film 134 which consists of silicon nitride with a thickness of 4000A by the plasma-CVD method is formed.
[0068] In a process a3, an a-Si layer with a thickness of 1000A it is thin in the semi-conductor layer 135, and an n+ mold a-Si layer with a thickness of 400A it is thin in the contact layer 141 are continuously formed in this order. Patterning of the formed n+ mold a-Si layer and an a-Si layer is performed, and the semi-conductor layer 135 and the contact layer 141 are formed. At a process a4, a molybdenum metal with a thickness of 2000A is formed by the spatter all over a substrate 131, patterning of this molybdenum metal layer is performed, the source electrode 136, the drain electrode 137, and the source bus wiring 139 are formed, and TFT140 is completed. Drawing 13 (1) is the sectional view of a substrate 131 in which TFT140 after the processing termination to a process a4 was formed.
[0069] At a process a5, a photoresist (trade name: OFPR-800) is applied to the thickness of 1200A all over the substrate [in which TFT140 was formed] 131 top, and using the mask 151 shown in drawing 14 , as shown in drawing 13 (2), heights 142a is formed. As shown in the formation field of a reflector 138 at drawing 14 , the circular protection-from-light fields 151a and 151b shown with a slash are irregularly formed in the mask 151. The diameter D1 of protection-from-light field 151a is formed more greatly than the diameter D2 of protection-from-light field 151b. For example, a diameter D1 is 10 micrometers and a diameter D2 is 5 micrometers. Diameters D1 and D2 have desirable 20 micrometers or less respectively. With the gestalt of this operation, although the mask 151 which has two kinds of protection-from-light fields 151a and 151b was used, a mask 151 is not limited to this. a protection-from-light field -- one kind -- being circular -- moreover, three or more kinds -- being circular . Then, it heat-treats, and as shown in drawing 13 (2), heights 142a is formed in the configuration the rough edge of the character of a configuration was rounded off.
[0070] At a process a6, polyimide resin is applied to the thickness of 1 micrometer all over a substrate 131 top, and as shown in drawing 13 (3), an organic compound insulator 142 is formed. At a process a7, a contact hole 143 is formed in an organic compound insulator 142 using a HOTORISO graphic method and the dry etching method.
[0071] At a process a8, as shown in drawing 13 (4) all over the organic-compound-insulator 142 top which has heights 142b, the metal thin film which consists of aluminum is formed, and as shown in drawing 13 (5), by the process a9, patterning of the reflector 138 is carried out on heights 142b. The reflector 138 is connected with the drain electrode 137 of TFT140 through the contact hole 143 formed

in the organic compound insulator 142. Even if heights 142a which consists of the photoresist under an organic compound insulator 142 at the time of patterning of a reflector 138 lets the process of exposure, development, etching of aluminum, and exfoliation of a resist pass, it is checking that change of what is not seen, either.

[0072] It is checked that the configuration of heights 142a is controllable by the configuration of a mask 151 and the thickness of a photoresist it is thin to heights 142a. Moreover, the angle of heights 142a can be easily taken by carrying out heat treatment after formation of heights 142a.

[0073] The electrode 147 formed in the substrate 145 of another side shown in drawing 10 consists of ITO, and thickness is 1000A. An electrode 138 and the orientation film 144 and 148 on 147 are formed by calcinating after applying polyimide etc. Between a substrate 131 and 145, by screen-stenciling the adhesive sealing compound which mixed the 7-micrometer spacer and which is not illustrated, the space which encloses liquid crystal 149 is formed and liquid crystal 149 is poured in by carrying out the vacuum deairing of said space. What mixed the optically active substance (the Merck [Co.] make, a trade name: S811) in the guest host liquid crystal (the Merck [Co.] make, a trade name: ZLI2327) which mixed the pigmentum nigrum, for example 4.5% as liquid crystal 149 is used.

[0074] Drawing 15 is process drawing explaining the production process of the reflecting plate 170 used for measurement of the reflection property of the reflective mold liquid crystal display 130 of this invention, and drawing 16 is a sectional view explaining each process of drawing 15 . a process b1 shows to drawing 16 (1) -- as -- glass (a trade name, 7059: Corning, Inc. make) 171 with a thickness of 1.1mm -- on the other hand, OFTR-800 (Tokyo adaptation shrine make) is preferably applied to a front face with a spin coat by 500rpm - 3000rpm as a resist ingredient. With the gestalt of this operation, it applied for 30 seconds by 3000rpm, and 1.2 micrometers of resists 172 were formed.

[0075] The resist 172 was prebaked for 30 minutes at 100 degrees C, at the process b2, by the process b3, as shown in drawing 16 (2), it exposed by arranging the photo mask 151 which has the circular protection-from-light fields 151a and 151b on a resist 172, and as shown in drawing 16 (3), the resist 172 was developed and the heights 174 of an irregular approximate circle pilaster were formed [the process b4] in substrate 171 front face. As a developer, 2.38% of NMD-3 (Tokyo adaptation shrine make) was used.

[0076] At a process b5, if the heights 174 on a glass substrate 171 are preferably heat-treated at 120 degrees C - 250 degrees C, as shown in drawing 16 (4), an angle can be taken and the smooth spherical-surface-like heights 174 will be formed. The gestalt of this operation performed heat treatment for 30 minutes at 180 degrees C. At the process b6, organic-compound-insulator 174a was formed on the substrate 171 which formed heights 174 as shown in drawing 1616 (5). As organic-compound-insulator 174a, polyimide resin is preferably applied with a spin coat for 20 seconds by 920rpm - 3500rpm. With the gestalt of this operation, it applied for 20 seconds by 2200rpm, and organic-compound-insulator 74a with a thickness of 1 micrometer was formed. Although the heights according to heights 174 arise in organic-compound-insulator 174a, it is smoother than heights 174.

[0077] At the process b7, as shown in drawing 16 (6), the metal thin film 175 was formed on organic-compound-insulator 174a. Aluminum, nickel, chromium, silver, copper, etc. can mention as a metal thin film 175. As for the thickness of the metal thin film 175, 0.01 micrometers - about 1.0 micrometers are suitable. With the gestalt of this operation, the metal thin film 175 was formed by carrying out vacuum deposition of the aluminum. Since the metal thin film 175 is formed on organic-compound-insulator 174a formed along with heights 174, it has irregular circular heights 175a according to heights 174. The reflecting plate 170 was obtained by the above.

[0078] Drawing 17 is a side elevation explaining the measuring method of the reflection property of a reflecting plate 170. Usually, the refractive index of the substrates 131 and 145 used for a liquid crystal display 130 and 149 layers of liquid crystal is about 1.5, respectively. Supposing the configuration which 149 layers of liquid crystal meet with on the front face of a reflecting plate 170, with the gestalt of this operation, the glass substrate 176 was stuck to the reflecting plate 170 using the ultraviolet-rays

hardening resin 177 of a refractive index 1.5, and the reflection property of a reflecting plate 170 was measured. This measurement result is checking giving the same result as the front face of a reflecting plate 175, and the reflection property in the boundary of 149 layers of liquid crystal. [0079] As shown in drawing 17 , measurement of a reflection property is performed by detecting the scattered light 180 of the incident light 179 which carries out incidence to a reflecting plate 170 by the phot multimeter 178. Incident light 179 carries out incidence to a reflecting plate 170 with an include angle theta to the normal. The phot multimeter 178 is being fixed in the direction of a normal of the reflecting plate 170 which passes along the point that the incident light 179 on the metal thin film 175 is irradiated. The reflection property was obtained by replacing theta with whenever [incident angle / of incident light 179], and measuring the reinforcement of the scattered light 180 by the metal thin film 175 of incident light 179.

[0080] Drawing 18 is a graph which shows the relation between theta and reflectivity whenever [incident angle]. The reflectivity of the incident light 179 which is whenever [incident angle / theta] is expressed in the include-angle theta direction to a theta= 0-degree line as a distance from a zero 0. the reflectivity of theta= 70 degrees -- the reflectivity of P1 and theta= 60 degrees -- the reflectivity of P2 and theta= 40 degrees -- the reflectivity of P3 and theta= 30 degrees -- reflectivity (P4 and theta=-30 degree) -- P5 and theta= -- P8 shows [the reflectivity of -40 degrees] P7 and theta=-70 degree reflectivity for P6 and theta=-60 degree reflectivity.

[0081] In drawing 18 , the broken line 81 shows the reflection property curve of the standard white plate of a magnesium oxide. It turns out that the reflectivity P4 of theta= 30 degrees is superior to the reflectivity P10 of a theta= 30-degree magnesium oxide, and theta=-30 degree reflectivity is also superior to the reflectivity P11 of a theta=-30 degree magnesium oxide.

[0082] As mentioned above, according to the gestalt of this operation, control of a configuration is easy and forms the reflector 138 in alignment with heights 142b on the organic compound insulator 142 which has heights 142b formed along with heights 142a convex section 142a which consists of the photoresist which has repeatability. By controlling the configuration of heights 142a, the reflector 138 which has a good reflection property is obtained, and the display grace of the reflective mold liquid crystal display 130 improves.

[0083] As for the above-mentioned photo mask 151, it is desirable to use a thing as shown in drawing 19 . In drawing 19 (1), the gross area of the protection-from-light fields 151a and 151b is about 47% of a gross area of a mask 151, and the gross area of the protection-from-light fields 151a and 151b is 41% of a gross area of a mask 151 in drawing 19 (2).

[0084] Drawing 20 is a graph which shows the relation between theta and reflectivity whenever [in the reflective thin film 75,175 with which the protection-from-light fields 151a and 151b were formed using the mask 51,151 which occupies 40% or more of a gross area / incident angle]. The reflectivity of the incident light 78,178 which is whenever [incident angle / theta] is expressed in the include-angle theta direction to a theta= 0-degree line as a distance from a zero 0. The reflectivity of theta= 70 degrees P21 and the reflectivity of theta= 60 degrees P22 and the reflectivity of theta= 40 degrees the reflectivity of P23 and theta= 30 degrees -- the reflectivity of P24 and theta= 25 degrees -- reflectivity (P25 and theta=-25 degree) -- reflectivity (P26 and theta=-30 degree) -- P27 and theta= -- P30 shows [the reflectivity of -40 degrees] P29 and theta=-70 degree reflectivity for P28 and theta=-60 degree reflectivity.

[0085] In drawing 20 , the broken line 181 shows the reflection property curve of the standard white plate of a magnesium oxide. It turns out that the reflectivity P24 of theta= 30 degrees is superior to the reflectivity P34 of a theta= 30-degree magnesium oxide, and the theta=-30 degree reflectivity P27 is also superior to the reflectivity P37 of a theta=-30 degree magnesium oxide.

[0086] On the other hand, the protection-from-light fields 151a and 151b show the reflection property of a reflecting plate to drawing 21 by the same approach using the photo mask 151 of less than 40% of a gross area, for example, 35%. It turns out that the reflectivity P54 of theta= 30 degrees is inferior to the

reflectivity P44 of a theta= 30-degree magnesium oxide, and the theta=-30 degree reflectivity P57 is also inferior to the reflectivity P47 of a theta=-30 degree magnesium oxide. This has very many specular reflection components as heights are less than 40%, and since there is little dispersion, it is considered that the visual field was narrowed.

[0087] Drawing 22 shows the theta= 30-degree reflection factor of the reflecting plate created using the photo mask 151 to which the rate of occupying to the gross area of the mask of the protection-from-light fields 151a and 151b was changed. By making the rate of heights into 40% or more from drawing 22 shows that the reflecting plate of a high reflection factor is obtained. In addition, by choosing the class of photoresist, and thickness and heat treatment temperature, whenever [tilt-angle / of heights] can be controlled freely and a reflection property can be controlled by this. Moreover, a reflection property is controllable also by the class and thickness of an organic compound insulator.

[0088] In the reflective mold liquid crystal display 130 of the gestalt of this operation, since the field in which the reflector 138 was formed is located in a liquid crystal 149 side, parallax is lost, and the good display screen is obtained. Moreover, with the gestalt of this operation, since the reflector 138 which has irregularity serves as a configuration arranged in the location which adjoins mostly 149 layers of 149 layer sides of liquid crystal, i.e., liquid crystal, the height H1 of heights 142b is smaller than liquid crystal thickness, and can make whenever [tilt-angle / of heights] quiet to extent which does not disturb the orientation of a liquid crystal molecule. Moreover, with the gestalt of this operation, also although heights 142a is formed only in a reflector 138 formation field and it excels in it, heights 142a may be formed all over substrate 131. Moreover, a reflecting plate may be independently formed by using a reflector 138 as a transparent electrode, and a reflecting plate is similarly formed also in this case on the organic compound insulator formed on two or more irregular heights. Moreover, also although it explains and excels about the reflective mold liquid crystal display 130 of a active-matrix drive method using TFT140 as a switching element, it is not restricted to this and the same effectiveness is acquired also with reflective mold liquid crystal displays, such as a passive-matrix drive method.

[0089] Furthermore, although patterning of an organic compound insulator 142 was performed by the dry etching method with the gestalt of this operation, when an organic compound insulator 142 is polyimide resin, you may carry out by the wet etching method by the alkali solution. Moreover, although polyimide resin was used as an organic compound insulator 142, other organic materials, such as acrylic resin, may be used. Furthermore, with the gestalt of this operation, as a substrate 131, although the transparent ingredient which consists of glass etc. was used, effectiveness with the same said of an opaque ingredient like a silicon substrate is demonstrated, and there is an advantage which can accumulate a circuit on a substrate in this case.

[0090] In addition, in the gestalt of said operation, although phase transition mold guest host mode was taken up as a display mode, effectiveness with the same said of the birefringence display mode which is not limited to this, for example, is used with other light absorption modes like a two-layer type guest host, a light-scattering mold display mode like a polymer dispersed liquid crystal display, and a ferroelectric liquid crystal display is acquired. Moreover, although the gestalt of this operation explained the case where TFT was used as a switching element, it is applicable to the active-matrix substrate using an MIM (Metal-Insulator-Metal) component, diode, a varistor, etc., for example.

[0091] Drawing 23 is a top view for explaining the gestalt of operation of this invention. The description of the gestalt of this operation is having formed the black protection-from-light layer 71 which consists of an electric insulation ingredient on the reflective mold active-matrix substrate 31 which formed irregularity as shown in above-mentioned drawing 2 R> 2. The black protection-from-light layer 71 is formed in the field which attached the slash in drawing 23 , i.e., fields other than reflector 38 and the formation field of the semi-conductor layer 35 which constitutes TFT40. In addition, the black protection-from-light layer 71 may be formed on the reflective mold active-matrix substrate 131 shown in above-mentioned drawing 10 and above-mentioned drawing 11 .

[0092] Drawing 24 is a sectional view for explaining the formation approach of the black protection-

from-light layer 71. Although here explained taking the case of the active-matrix substrate 31 shown in drawing 6 , the same is said of the case of the active-matrix substrate 131.
[0093] First, the photosensitive acrylic resin which distributed red and a blue and green pigment all over the substrate 31, respectively so that the light might be absorbed as shown in drawing 24 (1), for example, the Fuji hunt company make, a trade name: Apply the resin 71 which mixed three kinds of color mosaics CR, CG, and CB, and presented black using a spinner.
[0094] Then, as shown in drawing 24 (2), it exposed using the predetermined mask 72, and after developing negatives, as an unnecessary part was removed by etching and shown in drawing 24 (3), the black protection-from-light layer 71 was formed so that it might cover completely with fields other than reflector 38, and the formation field of the semi-conductor layer 35 which constitutes TFT41. Then, it heated at 200 degrees C for 1 hour, and the black protection-from-light layer 71 was stiffened.
[0095] As mentioned above, since according to the gestalt of this operation the black protection-from-light layer 71 is formed and the reflected light (scattered light) of parts other than reflector 38 was interrupted, the leakage of a light unnecessary for a display can be prevented, and the reflective mold liquid crystal display which was excellent in contrast can be realized. Moreover, compared with the case where the black protection-from-light layer 71 is formed on the substrate 45 which counters, the large margin at the time of substrate lamination can be taken, and the bright display which lessened decline in the numerical aperture by gap of substrate lamination can be realized.
[0096] The acrylic resin which distributed carbon although the acrylic resin which distributed the pigment was used as an ingredient of the black protection-from-light layer 71 with the gestalt of this operation, for example, the Fuji hunt company make, a trade name: Inorganic substances, such as an organic material like the color mosaic BK and non-electric-field plating of amorphous silicon germanium (a-SiGe;H) or silver, are also applicable. Moreover, in consideration of the absorption coefficient of the ingredient to be used, preferably, the thickness of the black protection-from-light layer 71 needs to set up permeability so that it may become 1% or less to at least 5% or less more preferably.
[0097]
[Effect of the Invention] As mentioned above, it is not necessary to form by array pattern which has the reflector with the same array pattern of said concave heights, therefore is different for every reflector, and, according to the reflective mold liquid crystal display of this invention, it becomes possible to form said concave heights in all the fields in which a reflector is formed easily. That is, since a protection-from-light field is formed by the respectively same array pattern on the photo mask of the field corresponding to a reflector, creation of a photo mask is [that what is necessary is just to form the array pattern corresponding to one reflector] easily possible.
[0098] Moreover, according to the manufacture approach of the reflective mold liquid crystal display of this invention, since the gross area of the protection-from-light field in which the pattern of said approximate circle form was formed is made into 40% or more of the gross area of a reflector, said protection-from-light means becomes possible [obtaining a high reflection factor]. That is, since a specular reflection component does not increase but dispersion increases by making the gross area of the protection-from-light field of a protection-from-light means into 40% or more of the gross area of a reflector, it is possible to obtain a high reflection factor in the viewing-angle range of an observer.

[Translation done.]

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view of the reflective mold liquid crystal display 30 which is 1 operation gestalt of this invention.
[Drawing 2] It is the top view of the substrate 31 shown in drawing 1 .
[Drawing 3] It is process drawing explaining the formation approach which forms the reflector 38 which has irregularity on the substrate 31 shown in drawing 1 and drawing 2 .
[Drawing 4] It is a sectional view explaining the formation approach shown in drawing 3 .
[Drawing 5] It is the top view of the mask 51 used at the process s7 of drawing 3 .
[Drawing 6] It is the sectional view showing the measuring method of the reflection property of a substrate 52 which has a reflector 38.
[Drawing 7] It is the graph which shows the reflection properties 60 and 61 of the reflective mold active-matrix substrates 52 and 59 of this invention.
[Drawing 8] It is the graph which showed the color of the reflected light to the white light source light of the reflective mold liquid crystal display 30 which is 1 operation gestalt of this invention in the CIE chromaticity diagram.
[Drawing 9] It is the top view of the substrate 31 in which 1 operation gestalt of this invention is shown.
[Drawing 10] It is the sectional view of the reflective mold liquid crystal display 130 which is 1 operation gestalt of this invention.
[Drawing 11] It is the top view of the substrate 131 shown in drawing 10 .
[Drawing 12] It is process drawing explaining the formation approach which forms the reflector 138 which has the heights shown in drawing 10 and drawing 11 .
[Drawing 13] It is a sectional view explaining the formation approach shown in drawing 12 .
[Drawing 14] It is the top view of the mask 151 used at the process a5 of drawing 12 .
[Drawing 15] It is process drawing explaining the production process of the reflecting plate 170 used for measurement of the reflection property of the reflective mold liquid crystal display 130 of this invention.
[Drawing 16] It is a sectional view explaining the process of drawing 15 .
[Drawing 17] It is a perspective view explaining the measuring method of the reflection property of a reflecting plate 170.
[Drawing 18] It is the graph which shows the relation between theta and reflectivity whenever [incident angle].
[Drawing 19] It is the top view showing a mask 51.
[Drawing 20] It is the graph which shows the relation between theta and reflectivity whenever [in the reflective thin film 75 with which the gross area of the protection-from-light fields 51a and 151a was formed using the mask 51 which is 40% or more of the gross area of a mask / incident angle].
[Drawing 21] It is the graph which shows the relation between theta and reflectivity whenever [in the reflective thin film 75 with which the gross area of protection-from-light field 151a was formed using the mask 151 which occupies 35% of the whole / incident angle].
[Drawing 22] It is the graph which shows the relation between the rate of a protection-from-light field, and a reflection factor.
[Drawing 23] It is a top view for explaining 1 operation gestalt of this invention.
[Drawing 24] It is a sectional view for explaining the formation approach of the black protection-from-light layer 71.

[Drawing 25] It is the top view of the substrate 2 which has the thin film transistor 1 which is the switching element used for an active matrix.
[Drawing 26] It is the sectional view seen from cutting plane line X26-X26 shown in drawing 25 .
[Drawing 27] It is the top view of the substrate 12 which has the thin film transistor 11 which is the switching element used for an active matrix.
[Drawing 28] It is the sectional view seen from cutting plane line X28-X28 shown in drawing 27 .
[Description of Notations]
30,130 Reflective mold liquid crystal display
31 45,131,145 Substrate
38,138 Reflector
42,142 Organic compound insulator
42a, 142a Heights
49,149 Liquid crystal
51,151 Photo mask

[Translation done.]